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PRÉCIS

OF

REPORTS, OPINIONS, AND OBSERVATIONS

ON THE

NAVIGATION

OF

THE RIVERS OF INDIA,

BY

STEAM VESSELS.

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THE importance, both as a measure of economy, of policy, and of humanity, of establishing a safe and expeditious mode of water conveyance between Calcutta and the upper provinces of India, had occupied the attention of Lord William Bentinck; and scarcely had his lordship assumed the government of India in June 1828, when I received the commands of the Governor General to report on the practicability of employing Steam Vessels on the Ganges—a river which, differing in many points from those of Europe and America, where this means of conveyance and communication had been long established on general principles, required a system adapted to its peculiarities; the most remarkable of which stood recorded in the valuable work of Major Rennell, whilst minuter

circumstances were to be elicited from boatmen and others serving on its waters; and further information connected with demand and expense, was to be obtained from the documents in public offices, and those of the River Insurance Companies established in Calcutta.

As it would be impossible, without drawing out this paper to an inconvenient length, to include in it all that is interesting and intelligent in the different reports and observations which have been made on the subject of Inland Steam Navigation, or to notice every circumstance that in the course of different experiments have been deemed worthy of record, I shall limit my statement to matters of admitted fact; to results and conclusions, without detailing the evidences, or the means employed to establish and to arrive at them. Suffice it to say, that with the above data, I was enabled to submit an opinion decidedly favourable to the undertaking; which was supported by a note by Captain Forbes, superintendent of Steam Engines, illustrative of the principles required in steam boats adapted to this particular service; and confirmed by a paper from the able pen of Thoby Prinsep,

Esq., Secretary to Government in the General Department, taking a comprehensive view of the subject, both as regarded the existing and the contemplated system of navigation, and setting forth in the strongest light the advantages that might be expected from the success of the project.

These reports were followed by an order of the Governor General in Council, commanding that an experimental voyage to Allahabad should be forthwith made in the Hoogly steam vessel.

I had the honour of being selected by his Lordship the Governor General to conduct this first experiment; and Captain Prinsep, of the Engineers, an officer whose melancholy death was felt no less as a public loss, than deplored as a domestic bereavement, was appointed to remark upon such circumstances attending the voyage as fell peculiarly within the province of his profession. On his return to Calcutta he published a series of Charts, corrected from the surveys of Rennell and Colebrook in 1782 and 1801, exhibiting the changes which had taken place in the course of the Ganges and Bhagaretty since those periods; which being projected

on a scale of half an inch to the mile, are well adapted to guide the traveller who may commit his fortunes to the streams of those rivers.

The Hoogly, one of the two vessels built purposely for the navigation of the Bruhmapootra, measures at the load water-line, between rabbit and rabbit, ninety-eight feet, with eighteen feet of beam; her length over all one hundred and five feet, and her breadth outside the paddle boxes thirty. She had a perfectly flat bottom, a square section continuing uniformly forwards and aft, with a very slight entrance and run; she was fitted with two engines by Maudsley, of the united power of fifty horses, and with the steam up when ready to start, with 806 maunds or thirty tons of Burdwan coal (equal to eighty hours' consumption), of which 300 maunds were stowed on the deck; and with fifteen tons of other stores and baggage—in all about forty-five tons weight, exclusive of anchors and cables, masts, a boat, and cooking places, the Hoogly drew forwards four feet six inches, and abaft three feet ten inches water.

On the 8th September, at 7° 30′ A. M. we broke ground from the Coolie Bazar, and pro-

ceeded through the Bhagaretty by the Sootee mouth into the Ganges, which was entered on the 13th, at 5° 10′ P. M.; and we arrived at Allahabad, a distance of 798 miles, on the 1st October, at 9° 10′ A. M., being the twenty-third day from that of our departure, of which two had been passed at anchor at Patna and Benares. We had been under steam 240 hours, proceeding at an average rate of $3\frac{1}{3}$ miles per hour over the ground. Our average speed, I am of opinion, did not exceed $6\frac{1}{2}$ miles per hour, which will leave $2\frac{2}{3}$ for the average rate of the current experienced, and I believe it did not, on any occasion, exceed six miles (above Ghazeepore it was less); but we generally avoided its strength by keeping on the edges of the sands. We left Allahabad on the 3d October, and arrived in Calcutta on the 17th, having been detained one day on a sand-bank, and two at Benares, to procure anchors, &c. &c. This experiment, made in a season when the current is said to run at its greatest velocity, elicited the following facts and observations.

1. The practicability of navigating on the Ganges with a steam vessel.

2. That vessels for that purpose must possess more than six miles speed per hour; or in some narrow parts of the river, where there is no possibility of avoiding the strength of the current, they would not progress.

3. That to be able to proceed at all seasons, and at the lowest state of the river, the vessels should not exceed a draft of two feet.

4. That this draft would, in the season of strong currents and deep water, admit of the vessels proceeding generally, in shallow water, out of the influence of the currents, and very much accelerate their progress.

5. That above Patna, the river is less subject to alteration than below that place; and that above Ghazeepore, so little alteration has taken place in the bed of the river, that, with a few exceptions, the sands laid down by Rennell and Colebrook still retain their form and position.

6. That much caution is required in descending the stream with a rapid current, and that stern anchors, and good ground tackle, are both imperatively necessary.

7. That, by a steamer, the bank may always

be avoided on anchoring, and safe anchorage found within some sand.

8. That very few men can be obtained as pilots who know any thing about the river; and that to ensure efficiency in this department, it will be necessary to establish men at distances of not more than twenty miles apart below Ghazeepore, and forty above that place, with boats and other means of watching the daily variations of the river, and of sounding its channels.

The attention of the scientific gentlemen in all the government departments was now directed to the means of reducing the weight of marine engines and the draft of steam vessels, but nothing practical was elicited. In February 1829, a series of trials was commenced upon, to ascertain the ratio in which the velocity of the river steam vessels would be affected by towing different classes of boats. The first trial was made under the direction of Captain Clapperton, in the Burhmapootra, a sister vessel to the Hoogly, without any tow, to ascertain her speed, hitherto undetermined: the result was, a mean rate of 6½ nautical miles per hour. The Burhmapootra's coal-boxes were full, her stores

and provisions on board for one month, and her draft was, forwards 4 feet 2 in., aft 3 feet 1 in. These experiments were not now followed up, but it was determined to attempt a second voyage to Allahabad, by steam, and, on the 17th March, the Hoogly left Calcutta, at a draft of 4 feet 3 in. forwards, and 3 feet 6 in. aft, under the direction of Mr. Warden, a very intelligent officer of the Pilot service, who had commanded the vessel under my orders on the former voyage. The rivers were now at their lowest ebb, and the Nuddeah rivers being impassable for boats exceeding a draft of 2 feet 6 inches, the route by the Sunderbunds was necessarily resorted to.

The distance from Calcutta to Rajhmahl, by the Bhagaretty, is 250 miles, and, by the Sunderbunds, Mr. Warden estimates it 524 miles; but, in the passage of the Sunderbunds, the progress is more rapid, the tides and currents being as frequently in favour of, as opposed to, the course of the vessel. This route usually adds seven days to the duration of the passage of a country boat to any point of the great river west of the Bhagaretty. In the steam vessel

it made a difference of 4 days, and of steaming 25 hours and 21 minutes.

The Hoogly reached Kutchera, a village nineteen miles to the west of Chunar, on the 9th April; here her progress was arrested by a shoal bank extending entirely across the river, and having at the deepest part not more than two feet six inches, with a current running over it with a velocity of one mile per hour. Major Rennell's information was therefore incorrect, which led him to assert that below Allahabad the river Ganges was no where fordable by an elephant.

The experience of this voyage went to prove:

1st. That the route by the Lower Sunderbunds into the great river may be adopted by steam-vessels, and will add only four days to the length of the voyage when bound to the westward of Bogwangola, and that the consumption of fuel will be increased from twenty-five to thirty hours.

2d. That anchoring in the Sunderbunds at night, narrow channels and creeks should be avoided on account of numerous large wood

boats, which are likely to impede the passage, or to drift on board.

3d. That the current in the Ganges running at this season with a diminished velocity, the progress of a steam-boat will be attended with a proportionate increase, when the want of pilots and the consequent difficulty of discovering the proper channels, shall no longer operate to cause delay.

4th. That in the present state of the great river, the channels are not entirely free from the trunks of fallen trees.*

5th. That there are Konkar Rocks off the village of Kyté. Mr. Warden found the velocity of the current above Benares one to one and a half, off Dinapore two, and in the lower parts of the Ganges two and a half miles per hour, and not exceeding five in confined parts of the river and in narrow channels. The heat during this voyage was very oppressive, the thermometer standing at 104° in the shade.

* At the low water season, the bed of the river may easily be cleared of the existing obstacles of this nature, and the cultivated state of the banks of the Ganges will render it an easy task to prevent other trees from falling into the stream.

For the purpose of bringing into one view the results of three voyages made by the Hoogly on the great river, I will here notice her trip to Benares in attendance on the Governor-General in January 1830, on which occasion, besides 500 maunds of coal, she embarked forty tons of baggage and sixty-three native servants. Her draft, four feet seven inches forwards and four feet one inch abaft, making her mean draft two inches in excess of that of the first voyage, and five and a half of that of the second, occasioned a sensible diminution of her speed.

Her passage through the Sunderbunds, rendered necessary by the low state of the rivers, was nevertheless accomplished in eight hours, forty minutes less time than on the preceding occasion, a circumstance attributable to a better acquaintance with the route.

The Hoogly was on this occasion commanded by Mr. Wall of the pilot service, an intelligent young man, who on the previous voyages served in the capacity of mate. His report fully confirmed the correctness of former observations. Mr. Wall also noticed that, on approaching a shoal against the current, the vessels dipped

considerably by the head, an effect easily conceived by any one who has observed the hollow immediately on the lower side of any obstacle parting the waters of a running stream, or that which occurs immediately in the wake of a ship moving through the sea, occasioning what writers on the resistance of fluids term minus pressure.

The insufficiency, and principally arising from the excessive heat, the untenantableness of the accommodation afforded by the river steamers, rendered it very desirable that the passengers at least should be conveyed in a separate boat, towed by the steamer; and to determine on the practicability of this mode, both as respected the power of the steam boat and the possibility of steering or manœuvering with one or more boats in tow, in violent currents and whirling eddies, I was desired to resume the experiments already mentioned as having been commenced in February, when the speed of the Burhmapootra was computed at six and nearly a half nautical miles per hour.

The experiments that can be made in a river, the velocity of whose tides, from different

causes, is subjected to many variations, may yield results which, though sufficiently correct for the general purposes of navigation, cannot serve as data for calculations in which a great degree of accuracy is required. The following results must therefore be considered as of the first named order. The draft of the Burhmapootra was maintained throughout these experiments within half an inch of that at which her speed had been tried in February, *viz.* forwards four feet one and a half inch, abaft three feet and a half.

The vessels towed were,

No. 1. The Soonamookee, about 80 tons.

No. 2. A budgerow of sixteen oars, with masts, about 30 tons.

No. 3. A pinnace of twelve oars, with masts, about 50 tons.

The results were,

1. That the speed of the Burhmapootra did not exceed six knots and a quarter per hour, being nearly a quarter less than the result of Captain Clapperton's experiment in February.

2. That with three boats in tow, brought in as close order as their bowsprits would admit, they were under complete command, and the

speed was reduced one mile and a quarter, or one-fifth.

3. That with the boat No. 1 in tow, the vessel was completely under command, and the speed reduced half a knot, or little more than one-twelfth.

4. That with the same boat lashed alongside, the vessels were under command, and the speed was reduced one mile, or the effect of resistance was doubled.

5. That the head pressure of a vessel towed is much diminished when she is brought close up to the tug, so as to fall into the hollow of her wake, the resistance opposed is then little more than what is occasioned by friction; but when lashed alongside, both vessels are exposed to the full effect of bow pressure.

6. That when the breadth of the tow exceeds that of the tug, the resistance is increased by the accelerated force with which the tail water of the paddles strikes the bow of the tow.*

* When the tow has a greater beam or breadth in the water than the tug, I recommend the paddle-boards being set at a very small angle with the axis of the wheel, the outer end of the

Favourable as these results appeared, yet to put the question beyond all doubt, on the 12th of July, when the freshes had entered the Bhagaretty river, I left Calcutta in the Burhmapootra, at a draft of four feet two inches forwards, and three feet ten inches abaft, with the Hoogly in tow, her chimney unshipped, and her paddle-wheels dismounted; she carried two days fuel for the Burhmapootra, and was at a draft of three feet eight inches, and two feet ten inches, making the area of her immersed section twelve square feet in excess of that of an accommodation-boat, capable of embarking sixty tons weight at a draft of two feet, a plan and model of which was before Government. I reached Berhampoor on the 16th at noon, having steamed a distance of 174 miles in fifty-five hours against a current, averaging, by the result of several experiments, three miles an hour, making five miles and three-quarters per hour, the average rate at which the vessel had

paddle inclining forwards; this will, of course, reduce in a trifling degree the effect of power exerted by the engines, but will be more than compensated by throwing the tail water in a direction to escape the bow of the tow.

moved through the water. We encountered several strong eddies and sharp turnings, which were passed without difficulty, the vessel in tow acting as a powerful rudder on the steamer. We steamed nineteen hours on our return, at an average rate of nine miles per hour.

Pending these trials, and by order of the Governor-General, five queries were proposed to intelligent gentlemen connected with and in the employ of Government. The opinions given in answer to the 1st and 5th, were unanimously favourable to placing the engines in vessels separate from the accommodation-boats, and generally opposed to the adoption of high-pressure engines. The 3d and 4th it is unnecessary to notice here, as they referred not to the *general* subject. The second, *viz.* what is the best form and construction for a river tug, capable of taking in tow a large accommodation vessel, and having the smallest possible draft of water, being of the greatest importance, was extended to the public, and a premium of 1,000 rupees was offered by the Government for the most approved plan delivered on or before the 1st of August. Of the competitors for this

prize, Captain Cowles was successful: the boat, a beautiful model of which he subsequently made by order of Government, was to be 130 feet long, thirty feet four inches broad, and with two twenty-five-horse engines, and twenty-four tons of coals and stores, to draw two feet water. The Committee appointed to decide on the respective merits of the plans submitted, recommended to the liberal consideration of Government that of Mr. Macnaught, Engineer, in the employ of Messrs. Scott and Hunter, for a high-pressure tug; and the Government was pleased to award a donation of 500 rupees. Other plans, possessing different degrees of merit, were furnished to Government by gentlemen who were not competitors for the premium. The most approved, and that finally adopted, was by Captain Forbes. A vessel on this plan, 112 feet long and eighteen feet broad, was launched from the dock-yard of Messrs. Kyd and Co. on the 8th of October, at a draft of ten inches; loaded with thirty tons of kintledge the draft was one foot eight inches; with fifty tons two feet.

This vessel, calculated for a single engine,

was so planned and constructed, in consequence of some experiments made by order of the Right Honourable the Governor-General, the results of which went to confirm his Lordship's opinion of the sufficiency of a single engine of twenty-five-horse power, placed in a light tug, to tow an accommodation vessel of the dimensions of the Hoogly or Burhmapootra, a purpose to which either of those vessels was readily convertible, and their engines and boilers with little alteration might, it was determined, be placed separately in the proposed tugs. The uncertainty of having new boats equipped in time to convey the Governor-General to the Upper Provinces, prevented for the present the dismounting either of the existing steam-vessels; and the new boat, after launching, being found capable of receiving a single engine of a much greater power than was originally contemplated, she will now probably await the arrival of a fitting one from England.*

* These experiments were made in the Burhmapootra, at a draft of four feet two inches forwards, and three feet one inch abaft, with one engine, and alternate paddle-boards taken off: the engine made twenty-six strokes, and the speed was five nautical miles per hour.

To enable me to form some idea of the resistance this boat at a draft of two feet would present to a moving power, I took her in tow of the Bruhmapootra, and found that she retarded the progress of that vessel less than one-eighth.

The Bruhmapootra's engines having been recently packed and adjusted, did not on this occasion work up to their full speed, and no opportunity offered of repeating the trial.

Thus has been established the practicability of navigating with steam vessels, and at all seasons, the principal rivers of India: the expediency, nay the necessity of the measure, is made evident by the following considerations.

1. The Ganges, the Jumna, the Megua, the Soorma, and Bruhmapootra, with such of their tributary streams as are navigable, afford, though an uncertain and an insufficient, yet the principal, and at particular seasons the only means of conveyance for persons or goods, between the presidency of Bengal and the principal cities and military stations of Hindostan and Assam, comprehending an area of more than two hundred thousand square miles.

2. The rapidity of the current, and the ever-

varying depths of the rivers, render oars and the pole unavailing as propelling powers; the track-rope and the wind alone can be looked to; the one always uncertain, and during several months opposing, the other impeded or obstructed in its action by the badness of the towing-path, or the deep ravines and inlets which continually present themselves. Hence the slow progress upwards of all description of boats, an average of twenty-five miles per day being considered rapid, and the time allowed by government and the boat owners calculated at a rate not exceeding ten. In the Bruhmapootra and Megna rivers, whose banks, less populous than those of the Ganges, and still covered with thick jungle, afford no path for tracking, progress can only be made during a portion of the year when the periodical winds are fair.

3. The entire dependence during the dry season on the track-rope by day, and the fear of losing ground by seeking anchorage for the night, exposes the boats to destruction by the falling in of the banks, whilst in the rainy months the breaking of the track-rope subjects them to no less a danger from the impetuosity

of the current. These accidents, of frequent occurrence, but to which the steam boat is not liable, are the principal causes of the high premium on insurance against the perils of a river voyage, averaging in amount the rate required on a voyage from England to India. The loss of human life is also very great, and it rarely happens that a movement of troops by water is unattended by casualties of this nature.

Besides the dilatory means of water conveyance, there is none for packages exceeding the weight of 25 lbs. For articles under this weight, and of moderate bulk, the dawk banghy offers the expensive and only mode of tolerably quick transport, still liable, during the inclement season, to the destructive effect of heavy rains and swollen rivers to be forded.

The only expeditious mode of travelling is the expensive and fatiguing dak, by which a single person is conveyed in a palanquin on men's shoulders at an average rate of three miles and a half per hour, at an expense of eight annas or sixteen pence per mile, and but very few persons can be thus accommodated on the same road at the same time.

To enumerate all the benefits derivable from an extensive, safe, and expeditious means of conveyance for goods and passengers, would be tedious and unnecessary, the experience of centuries has established the civilising and social effects of similar advantages.

Commerce, and thereby the public revenues, will become extended and increased, both by the facilities of intercourse and the consumption of many articles hitherto from their perishable nature unattainable in the remote provinces of the empire. The expenses of the Government will be reduced by the additional value communicated to the armed force of the country through the means of easy and rapid locomotion. The same facilities for the transit of stores, by admitting of their concentration, will render no longer necessary their accumulation in the various distant depots, where, though indispensable as a supply in case of possible exigency, they have generally been subjected to decay without being brought into use.

Much economy will attend the employment of steam vessels in the removal of treasure. Of 356 removals, which took place in 1829, thirty-

nine were, or might have been made by water. Treasure is always accompanied by a military escort, and that employed on the thirty-nine removals above mentioned, amounted to 90,000 men with their officers for one day.

These troops, besides the wear and tear to which they are exposed, and the expense of their conveyance, are allowed extra batta during the whole period of their employment on this service. In steam vessels such an escort would not be required.

It remains now to consider the question of expense both directly and comparatively, and the estimates I shall give are calculated on the supposition, that it will be found convenient to construct the tug vessels of sheet-copper. I believe that such vessels will travel at an average expense of 2 rupees 8 annas, or about five shillings per mile;* and if confined to the carriage of goods, will convey one pound weight 466 miles for one farthing. And although this is sixty or seventy per cent. higher than the present boat charges, without insurance, for conveyance with

* When natives shall have been trained as engineers, and the coal-beds on the Soane, &c. opened, this rate will probably be reduced one third.

one-third or one-fourth the celerity, it is less than one-fortieth of the expense of banghy conveyance, which, limited to packages of thirty pounds weight, and travelling in a more direct line than the steam vessels, will generally reach the same point in half the time. A rate between these two charges would ensure great demand for any portion of freight not required by the Government. If confined to the conveyance of troops, and the accommodation of officers and other passengers, the expenses will be much below the present rates; and as the same boats will at the same time accommodate passengers and convey stores or treasure, a considerable saving will be effected in this branch of the Government expenditure.

I regret that at present there exists no means of ascertaining the extent of demand for water conveyance on the rivers of India—it is very great. Major Rennell supposed, though I know not upon what data, that in 1780, not less than 30,000 boatmen found employment, and it is not too much to suppose that, from more extended commerce, that demand has been doubled; and assuming this to be the case, that more than

320,000 tons of boats are now employed. These boats are, however, rated much beyond their real capacity, and though for many years upwards of twenty-five thousand tons of boats have been annually engaged for the service of Government, the quantity of goods actually embarked has not perhaps exceeded in each year seven or eight thousand. This circumstance has been considered in the preceding estimate of the expense of water conveyance by the boats of the country.

To conclude, and to answer an objection that has been started by more than one person with whom I have conversed on the subject in question, I will observe, that not one native now employed in the boats would be liable to suffer from the establishment of steam vessels. The demand for water carriage frequently exceeds the available tonnage—it is always difficult to obtain boats for the service of Government, and in cases of emergency they can only be procured by compulsion.

JAMES H. JOHNSTON,
LIEUT. R.N.
Commanding Hon. Company's
Steam Vessels.

Calcutta, Oct. 14, 1830.